

Environmental Product Declaration

In accordance with ISO 14025:2006 for:

Gas Product

from

Mubadala Energy (Sebuku) Limited



THE INTERNATIONAL EPD® SYSTEM



THE INTERNATIONAL EPD SYSTEM

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Programme information

Programme:	The International EPD® System EPD International AB Box 210 60 SE-100 31 Stockholm Sweden www.environdec.com info@environdec.com EPD registered through the fully aligned regional hub: EPD Southeast Asia Kencana Tower Level M Bussiness Park Kebon Jeruk Jalan Raya Meruya Ilir Nomor 88, Jakarta Barat 11620 Indonesia www.epd-southeastasia.com
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Accountabilities for PCR, LCA and independent, third-party verification
Product Category Rules (PCR)
PCR 2023:05 Crude Petroleum and Natural Gas, Version 1.0
PCR review was conducted by: The Technical Committee of the International EPD® System. See www.environdec.com/TC for a list of members. Review chair: Claudia A. Peña, PINDA LCT SpA. The review panel may be contacted via the Secretariat www.environdec.com/contact
Life Cycle Assessment (LCA)
LCA accountability: PT ITS Tekno Sains LCA practioner: Dewa Indra Luqmana Budiono, S.T., M.T.
Third-party verification
Independent third-party verification of the declaration and data, according to ISO 14025:2006, via: <input checked="" type="checkbox"/> EPD verification by individual verifier Third-party verifier: Claudia A. Peña, PINDA LCT SpA Approved by: The International EPD® System
Procedure for follow-up of data during EPD validity involves third-party verifier: <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No

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Company Information

Owner of the EPD

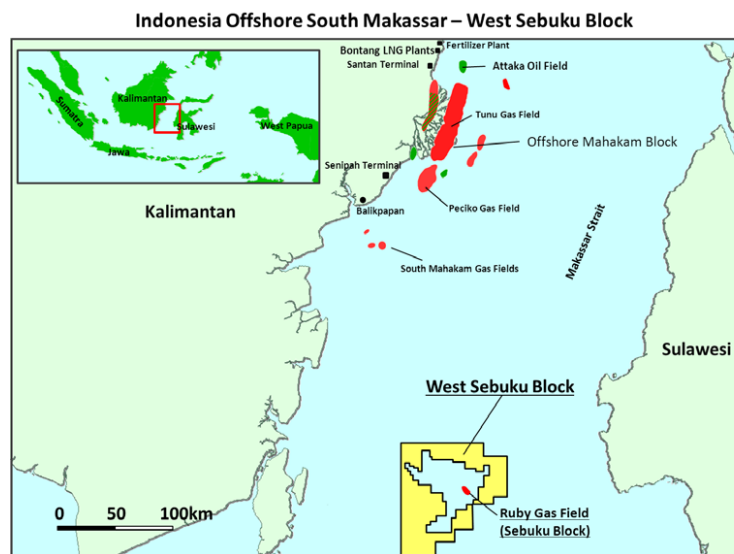
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Description of the organisation



Mubadala, an investment and business development company at the forefront of Abu Dhabi's economic diversification, is building on the Emirate's reputation as a reliable global energy supplier to maintain market share both domestically and internationally. Since 2002, Pearl has amassed a portfolio of exploration, development and production assets across 21 contract areas. The company's net production was approximately 19,000 barrels of oil per day at year-end 2007 from three fields in Indonesia and the Jasmine offshore field in the Gulf of Thailand.

Pearl's work program for 2008 consists of 13 seismic acquisition programs and the drilling of 24 exploration wells and 47 development wells mostly related to the expansion of oil fields in Thailand. The development of the Ruby gas field has been approved by BPMIGAS Indonesia. The development phase will involve field partners PearlOil (Sebuku) Limited, Total E&P Sebuku and INPEX South Makassar Ltd. Ruby is located in the Makassar Strait between Kalimantan and Sulawesi islands, within the Sebuku Production Sharing Contract area, operated by PearlOil (Sebuku) Limited, a wholly owned subsidiary of Pearl Energy which is the Southeast Asia operating arm of Mubadala Oil & Gas, a business unit of Mubadala Development Company. In 2022 Mubadala Petroleum launched its new brand name Mubadala Energy. Along with the rebranding, the business unit of Mubadala Energy Indonesia, previously known as PearlOil (Sebuku) Limited, was renamed Mubadala Energy (Sebuku) Limited.

Certification

- ISO 45001 : 2018
- ISO 14001 : 2015
- ISO 9001 : 2015
- Subroto Award
- Zero Accident Award
- Patra Nirbhaya Karya Utama
Adinugraha I Award
- Patra Karya Raksa Madya Award
- Green PROPER 2022-2023

Name and location of production site

Mubadal Energy (Sebuku) Limited is located in Makassar strait, Makassar, Indonesia

Product Information

Product name: Natural Gas

UN CPC code: UN CPC 120 (Crude Petroleum and Natural Gas)

Product description: Natural gas is an energy source derived from fossilized plants, animals, and microorganisms that have been stored underground for thousands or even millions of years. Natural gas products owned by Mubadala Energy (Sebuku) Limited have a gas specific gravity value of 0.5816, a mole weight value of 16.84 g/mol, a typical density of 0.042 lb/uft. The natural gas product that has been produced serves as an energy source that will be used by third parties consumers that is fertilizer factories and power plants.

Geographical scope:

The location of all processes is in Indonesia with the following details:

- All raw material suppliers are located in Indonesia
- Natural gas production is located in Makassar Strait, Indonesia
- Natural gas distribution to consumers is located in Kalimantan, Indonesia.

LCA Information

Declared unit: The declared unit used in the Mubadala Energy (Sebuku) Limited is 1 MJ of natural gas production. The reference flow of tonnes of oil equivalent (TOE) for both oil and natural gas equivalence to MJ as energy content shall be provided. Information on the conversion factor of barrel of oil or MMSCF of gas to TOE should be provided.

Time representativeness:

Specific data: The data period used is 1 year (January 1 - December 31, 2021)

Generic data: Generic data using databases collected from 2011 - 2021

Database(s) and LCA software used:

LCA was conducted using SimaPro version 9.5. Selected generic data used in this report was taken from Ecoinvent 3.8. The database used in the impact assessment of upstream, core, and downstream processes.

Description of system boundaries:

The boundary of the Mubadala Energy (Sebuku) Limited LCA study in 2022 is defined as Upstream to Downstream according to the PCR 2023:05 Crude Petroleum and Natural Gas, Version 1.0. The production system begins at the upstream scope. There are land use processes for drilling, drilling process, wellhead, production of materials, drilling infrastructure, well maintenance process, production and transportation diesel fuel, production and transportation of chemicals for core processes, production and transportation of lubricating oil for core processes, production and transportation of rags, production and transportation of batteries, production and transportation of filters, and production and transportation of activated carbon. In the drilling infrastructure process and the well drilling process, the dataset includes all materials used in the drilling process. These materials include the use of barite, bentonite, cement and organic chemicals, while the infrastructure includes concrete, steel, platforms, pipes, tubing and casing. In addition to the drilling materials and infrastructure, the dataset includes the waste generated from the drilling process that remains in the ground. So the use of the dataset has represented the well drilling process in the upstream scope.

Boundary towards nature based on PCR such as in oil and gas wells, can be categorized as recirculation of water/gas into the system. This is because the injected fluid is generally used to push hydrocarbons out of the reservoir (production) and not directly released into the atmosphere. Therefore, this process is not considered greenhouse gas emissions or environmental pollution. Furthermore, when underground infrastructure such as concrete, steel and other materials (e.g. drill bits, casing, pipes) are not removed after natural resource reserves are depleted or the materials are degraded, they are considered as emissions to land. Although the drilling process is generally controlled and gas leaks are avoided for safety reasons (explosion risk), methane emissions can still occur from geological infrastructure used in extraction activities. In actual conditions, the company's limits to nature are still not taken into account due to data limitations and data that are difficult to measure. So that the boundaries with nature that are still related are in the process of well drilling process at Mubadala Energy (Sebuku) Limited takes raw materials from nature in the form of natural gas. The natural gas production process produces several emissions to the air, namely CO₂, CH₄, N₂O, SO_x, NO_x, emissions to water such as BOD₅, COD, total ammonia, nitrates, and phosphates which cause impacts to the environment.

The main process (core) in this system is divided into gas transportation, separator, LP compressor, HP compressor, fuel gas system, gas metering, export pipeline, condensate export pump, condensate metering package, produced water treatment, gas turbine generator (GTG), sea water filter, drinking water maker, utility & living quarter, sewage treatment plant, land use, and emergency diesel. Then the downstream stage consists of the gas distribution process by pipeline to consumer (fertilizer), gas usage at fertilizer, gas distribution by pipeline to consumer (power plant),

LNG processing in power plant, gas usage at power plant. Gas from Mubadala Energy (Sebuku) Limited is distributed to Pupuk Kaltim industry and PLN TJ. Batu. Pupuk Kaltim uses the gas to fuel its fertilizer production process. For gas distributed to PLN Tj Batu, it is first processed into LNG at the Tj Batu gas station in PLN Tj Batu and then used for the powering process in PLN Tj Batu.

The reason for choosing the system boundary is in accordance with the agreement on the association and Product Category Rules (PCR). Data that can be collected and available at Mubadala Energy (Sebuku) Limited can cover the upstream to downstream study system boundary. The flowchart of the production process as well as the company's overall production system boundary can be seen in Figure 1 and descriptions in each process unit for the core processes have also been presented after the figure.

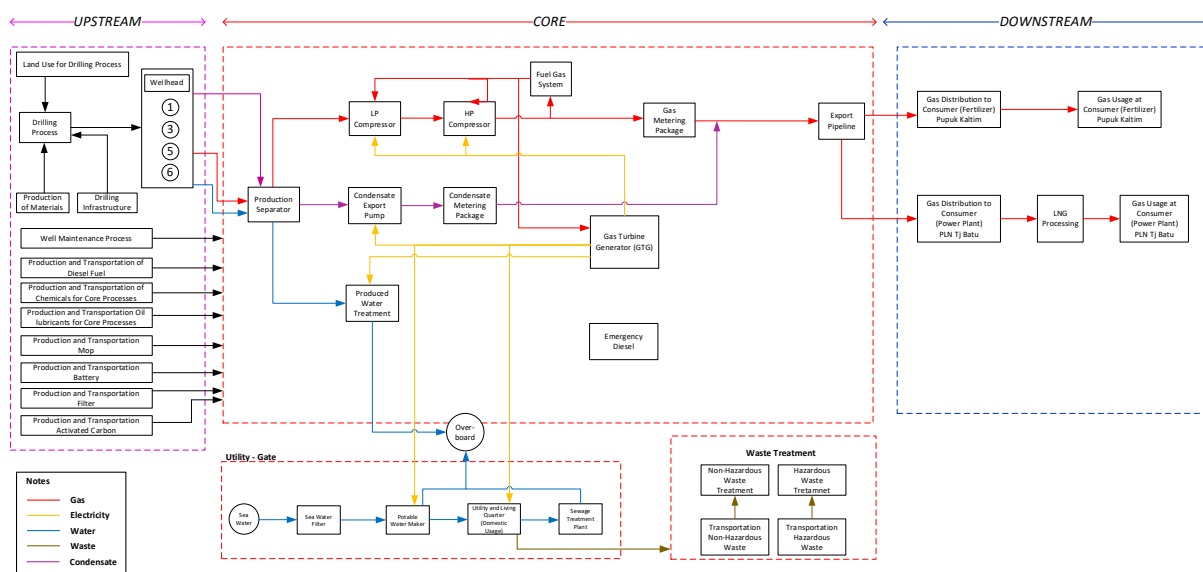


Figure 1. Diagram of Production System in Mubadala Energy (Sebuku) Limited

Description unit of core process :

- Separators : used to separate well fluids, namely liquids (oil and water), and gas from fluids (hydrocarbons) to pumps to transfer oil and inject production water.
- LP Compressor : the gas will flow to the compressor to be compressed to reach the required pressure so that the gas can be transported along the 312 km subsea export pipeline.
- HP Compressor : gas will be flowed to the compressor to be compressed to reach the required pressure so that the gas can be transported along the 312 km subsea export pipeline with high pressure.
- Fuel Gas System : this process unit is used for the production of fuel.
- Gas Metering : is provided on the PQP platform for storage metering of sales gas exported to the Senipah Onshore terminal. The metering package consists of 2 x 100% ultrasonic walk-through meters, flow computer and all necessary instrumentation and facilities for sales gas custody measurement.

- Condensate Export Pump : the condensate separated in the production separator is piped to the export gas pipeline by a condensate export pump. The condensate will be collected by condensate metering before being piped to the export pipeline.
- Condensate Metering Package : this process unit serves to measure the condensate content exported from the Ruby field to the onshore terminal.
- Produced Water Treatment : is a device used to treat produced water before it is returned to the sea.
- GTG : The main power plant for the entire platform is generated by a generator driven by a gas turbine, with a solid earth.
- Sea Water Filter : The sea water lifter is used to transfer sea water to the platform for various needs such as for fire water and drinking water source.
- Potable Water Maker : is the Potable Water System uses a reverse-osmosis (RO) unit to make potable water from seawater.
- The Utility & Living Quarter : is designed to provide accommodation for 30 people based on the requirement of 18 personnel for the operation and maintenance of the Ruby Field Facility offshore. However, the utility shall be designed for 40 persons on board.
- Sewage Treatment Plant : aerobic biological treatment process commonly known as aerated activated sludge. The extended aeration treatment concept requires a sewage treatment unit large enough to maintain and aerate the daily average sewage flow for 18 to 24 hours to keep the (sewage) supply essentially constant.
- Solid waste treatment : non-hazardous waste management unit at the company
- Hazardous waste treatment : hazardous waste management at the company which is carried out by a 3rd party.
- Emergency diesel : is one type of generator that is used as an alternative to electricity supply during an emergency situation such as a power outage or blackout.

More information:

Limitations: The following limitation were used in this LCA study:

1. Some upstream data is using datasets due to limited access to the supplier production of chemicals, lubricating oil, cement, and raw materials for well drilling infrastructure and also drilling process.
2. Downstream data uses LNG processing dataset for the natural gas o LNG process.
3. Downstream data uses natural gas transportation datasets to distributors using pipelines.

Assumptions: The following assumptions were used in this LCA study:

1. The use of annual data which is a conversion of daily data owned by the company.
2. The use of chemical approaches with compounds according to the company's MSDS because in the software SimaPro does not have company-owned chemical datasets available.
3. Calculation of the transportation distance of materials used in the production process using Google Earth.

Cut-off rules: Mubadala Energy (Sebuku) Limited is a company engaged in the exploration of natural gas production by producing the main product in the form of natural gas. In the process of preparing this LCA study in 2022, it is upstream to downstream, starting from natural gas production (upstream) to natural gas distribution (downstream). The cut-off criteria in the Mubadala Energy (Sebuku) Limited LCA study report use the principle of mass, energy and environmental criteria. Where all input and output data related to mass, energy and the environment in each process unit in the natural gas production system is 100% considered to have a direct impact on the environment, or in other words the cut-off used is at the 0% level.

Allocation: In this report, the impact of Mubadala Energy (Sebuku) Limited is considered to be the entire impact of the natural gas production process, so there is no allocation in the assessment of the main production process.

Data Collection Procedure

Mubadala Energy (Sebuku) Limited in 2021 collected data for each process unit included in the system boundary, including raw material data, fuel, electrical energy consumption, emissions to air, emissions to water, emissions to land, and land use data. The collected data is divided into 2 types of data, that is specific data and secondary data, in accordance with what has been determined in the PCR 2023:05 Crude Petroleum and Natural Gas, Version 1.0. The definitions of primary and secondary data are:

- a. Specific data : Data collected from actual manufacturing plants where product-specific processes are performed or actual data from other parts of the life cycle that are traced to the product under study, for example site-specific data on material production.
- b. generic data : Data from commercial and free databases that meet the data quality requirements of accuracy, completeness and representativeness.

Details of the inventory data used in this LCA are:

- Input
 - a. Raw material : Natural gas
 - b. Fuel/energy : Electricity, natural gas
 - c. Chemicals : Anti fouling and corrosion inhibitor
 - d. Water usage : Sea water
 - e. Other material use : Oil lubricant, industrial land use area
- Output and/or Product
 - a. Emissions to air : Carbon dioxide (CO₂), Methane (CH₄), Dinitrogen Monoxide (N₂O), Sulfur Oxides (SO_x), Nitrogen Oxides (NO_x), dan Particulates. Residual chlorine, Dissolved oxygen in situ, BOD 5, COD, ammonia, phosphate, nitrate, cyanide, sulfide, Polyaromatic Hydrocarbons (PAH), phenol, surfactants, Polychlor Biphenyls (PCB), oil & grease,
 - b. Emissions to water : pesticides (BHC, DDT, Endrin), Tributyl tin (TBT), Total Petroleum Hidrokarbon (TPH), mercury, chromium VI, arsenic, cadmium, copper, lead, zinc, nickel.
 - c. Hazardous waste : Used mop, used filter, used activated carbon, used battery, ex-corrosion inhibitors, ex anti-fouling, used lubricant oil.
 - d. Non Hazardous waste : Food waste, paper and cardboard, glass, plastic iron, and aluminium
 - e. Product : Natural Gas

Results of the Environmental Performance Indicators

Impact category indicators

The estimated impact results are only relative statements which do not indicate the end points of the impact categories, exceeding threshold values, safety margins or risks. The impact results presented below are the impact results per declared unit of natural gas products, which is per MJ. The results of the impact on the natural gas production process are presented in the impact category table analyzed in the LCA study report using the EN15804 method with the help of SimaPro software version 9.5, which includes EF 3.1.

PARAMETER		UNIT	Upstream	Core	Downstream	TOTAL
Global warming potential (GWP)	Fossil	kg CO ₂ eq/MJ	2.74E-03	2.03E-03	6.89E-02	7.36E-02
	Biogenic	kg CO ₂ eq/MJ	7.38E-05	3.04E-05	1.21E-04	2.25E-04
	Land use and land transformation	kg CO ₂ eq/MJ	1.70E-06	1.61E-06	6.02E-06	9.34E-06
	TOTAL	kg CO ₂ eq/MJ	2.74E-03	2.03E-03	6.89E-02	7.36E-02
Ozone layer depletion (ODP)		kg CFC 11 eq/MJ	3.11E-10	1.15E-11	2.35E-08	2.67E-09
Acidification potential (AP)		mol H ⁺ eq/MJ	1.27E-05	1.35E-05	1.33E-04	1.59E-04
Eutrophication potential (EP)	Aquatic freshwater	kg P eq/MJ	1.14E-06	2.47E-07	1.04E-06	2.43E-06
	Aquatic marine	kg N eq/MJ	2.76E-06	6.00E-06	5.89E-05	6.76E-05
	Aquatic terrestrial	mol N eq/MJ	2.87E-05	6.52E-05	6.43E-04	7.37E-04
Photochemical oxidant creation potential (POCP)		kg NMVOC eq/MJ	1.40E-05	1.68E-05	2.46E-04	2.77E-04
Abiotic depletion potential (ADP)	Metals and minerals*	kg Sb eq/MJ	9.63E-09	1.09E-08	2.35E-08	4.40E-08
	Fossil resources*	MJ/MJ, net colorofic value	4.62E-02	9.30E-03	1.13E+00	1.18E+00
Water deprivation potential (WDP)*		m ³ depriv/MJ	7.23E-04	4.32E-04	1.25E-03	2.40E-03

* Disclaimer: The results of this environmental impact indicator shall be used with care as the uncertainties of these results are high or as there is limited experience with the indicator.

Resource use indicators

PARAMETER		UNIT	Upstream	Core	Downstream	TOTAL
Primary energy resources – Renewable	Use as energy carrier	MJ/MJ, net calorific value	1.58E-03	5.76E-04	5.75E-04	2.73E-03
	Used as raw materials	MJ/MJ, net calorific value	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	TOTAL	MJ/MJ, net calorific value	1.58E-03	5.76E-04	5.75E-04	2.73E-03
Primary energy resources – Non-renewable	Use as energy carrier	MJ/MJ, net calorific value	9.39E-03	7.90E-03	7.87E-03	2.52E-02
	Used as raw materials	MJ/MJ, net calorific value	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	TOTAL	MJ/MJ, net calorific value	9.39E-03	7.90E-03	7.87E-03	2.52E-02
Secondary material (optional)		Kg/MJ	1.48E-03	5.67E-03	5.67E-03	1.28E-02
Renewable secondary fuels (optional)		MJ/MJ, net calorific value	1.67E-02	3.24E-03	3.24E-03	2.32E-02
Non-renewable secondary fuels (optional)		MJ/MJ, net calorific value	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Net use of fresh water (optional)		m ³ /MJ	8.87E-03	5.83E-05	5.82E-05	8.99E-03

Waste indicators

PARAMETER	UNIT	Upstream	Core	Downstream	TOTAL
Hazardous waste disposed	Kg/MJ	1.19E-10	4.27E-07	0.00E+00	4.27E-07
Non-hazardous waste disposed	Kg/MJ	1.69E-05	7.92E-08	0.00E+00	1.70E-05
Radioactive waste disposed	Kg/MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Output flow indicators

PARAMETER	UNIT	Upstream	Core	Downstream	TOTAL
Components for reuse	Kg/MJ	0	0	0	0
Material for recycling	Kg/MJ	0	0	0	0
Materials for energy recovery	Kg/MJ	0	0	0	0
Exported energy, electricity	MJ/MJ	0	0	0	0
Exported energy, thermal	MJ/MJ	0	0	0	0

Impact Contribution

The contribution of the impact resulting from the upstream to downstream at Mubadala Energy (Sebuku) Limited can be seen in the chart below. Most of the contributions come from the upstream, core processes, and downstream. Impact in the upstream mostly contributed by the drilling process. Meanwhile, impacts in the core process are contributed by the HP compressor and natural gas transportation. In the downstream process, resource mostly caused by gas distribution to customers.

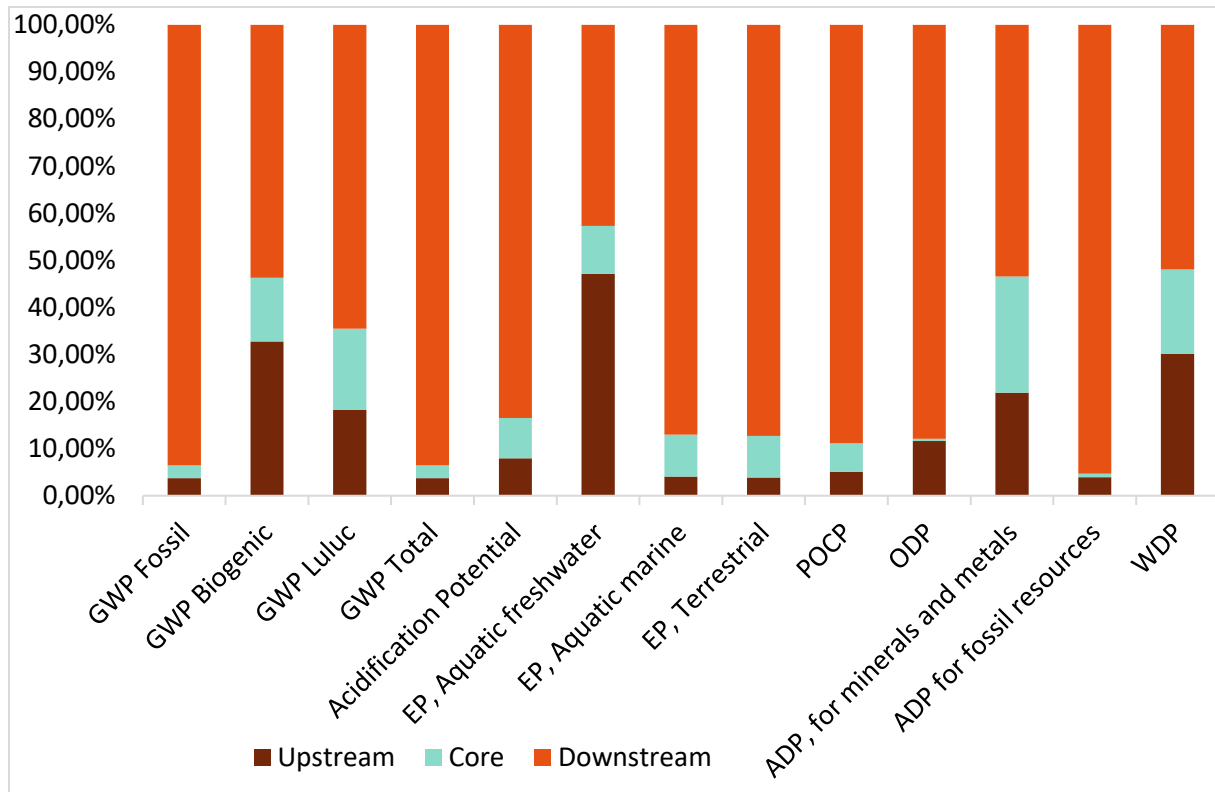


Figure 2. The Distribution of the Upstream to Downstream Impact Contribution

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